CCDP10001 Games & Playfulness

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**Rock-Paper-Scissors (RPS)**

**Aim:** to develop an artificial RPS player. The AI should feel like a human player, be difficult to beat, and be fun to play against. The interface should allow for smooth experience of these qualities.

Note: the accompanying demonstration can be opened with chrome or another browser.

Another note: source code for the demonstration has been included for interest, but is not expected to be marked. This can be opened with notepad++ or notepad.

**Part 1: Interface**

**Input:**

In the original, the mechanics of the hand play some role in shaping the theme and gameplay. As the average hand can make only simple shapes, “gazelle-lion-grass” and other games require significant imagination, hand distortion, or both.

The mechanics of the hand and the ‘fist’ starting position makes rock the default throw, de-equalising the perfect symmetry. Any input method will have similar bias, be it hand shapes that are similar to make, keys that are easier to reach, the button closest to the middle of the screen, or a word that is easier to pronounce.

One method for replicating the physical game uses different combinations of keys to mimic the throws: space bar for paper; q and e for scissors; i, o, p for paper. Another has the number of keys held simultaneously as the determining mechanism, to make it less of a typing/memory challenge, and more completely mimic the thought-to-motion processes of the physical game. Janken, a Japanese RPS robot, has a real hand to play with, and hand tracking technology, which makes human-vs-computer physical, unaltered matches possible. Short of this, however, most attempted mimicry using a keyboard would be clumsy and distracting. As the motion is ultimately not quintessential to the game, a simple button arrangement is more suitable.

The button arrangement I chose was triangular rather than linear to make each option equally reachable from a neutral mouse position. However, I made the ‘rock’ button be the same place as the ‘continue’ button to mimic the default positioning.

**Timing:**

In a physical game, the two players work together to determine the timing. This is important, as RPS becomes frustrating and seems unplayable if each party has a long period of time to think about it. However, because a triple-bluff comes full circle and is just playing the obvious, excessive rumination over what the opponent may do feels fruitless, and “not thinking too hard” becomes a reasonable approach, therefor players tend to self-regulate the timing. An in-game timer is added complexity and difficult to get exactly right.

**Output**:

When played normally, RPS players sometimes emphasise the winner by miming the associated action: covering a person’s rock with your paper, ‘cutting’ their paper with your scissors, and, most dramatically, bashing their scissors with you rock. This physical embodiment of winning enhances the contrived conflict, and the likelihood of mild pain increases the stakes of the game.

Without displayed metrics players quickly lose interest. Perhaps this is because we are used to having scores or lives displayed when playing a video game, as opposed to a real life game. So, the outcome of each match (win, lose or draw) is displayed, the number of total wins and losses is recorded, and an additional scoring mechanism is introduced.

**Scoring:**

The standard game of RPS often uses a “best of three” scoring system, where the first person to win two games (draws being ignored) wins a larger prize, such as going first in some other game. When played for its own sake rather than acting as a glorified coin toss, it is often unscored. Since it is difficult to keep track of the number of games won, it is left to the individual to ‘feel’ whether or not they are winning. This approximate and subjective method of evaluation means that a player may feel like they are winning after a small streak, even if they have lost the majority of total games.

One way to capture this feeling of mastery is a ‘streak’ metric. Winning would increase the player’s streak by one, losing would reset the streak. Reaching a streak of 5 would allow the player to move to the next level. In testing, this accurately reflected a player’s perceived Mastery. That is, after winning 5 games without losing, players felt they had a good handle on the computer’s strategy, and could win many more games without difficulty. However, the feeling of Mastery came at a high cost: the frustration of getting close. Whether balance of challenge/frustration was right depended on the player; however, in many cases the game proved too challenging. As a compromise, a different ‘Mastery’ metric was used: win a point for winning a game, lose two points for losing a game, points can’t go below zero, and you reach the next level by reaching 6 points. This circumvented the frustration of nearly getting a streak of 5, then losing and having to start over from scratch. Once implemented, fewer players gave up before reaching the last level.

**Part 2: AI Strategies/Algorithms**

**Level One: ‘Doug’**

Doug plays rock every time, regardless of what the player does.

This is very easy to pick up on after a few turns, and very easy to beat, the winning strategy being simply ‘always play paper’. This round serves to introduce the mechanics of the game and ensure that all players find it approachable before the difficulty increases.

Some players found picking up on the simple pattern more difficult than expected. This is perhaps due to the mode of output, which emphasises the win-loss-draw status of each match and thus detracts attention to the AI’s actual moves.

Despite Doug’s simplicity, he does demonstrate important aspects of human play. Humans are more likely to play streaks of rock than any other shape. Perhaps this is due to the affordances of the hand, as discussed earlier.

When a human uses the strategy, it takes much longer for the opponent to catch on. This is because we suspect more complex reasoning, such as the lulling us into a false sense of security. Computers, on the other hand, are easily believed to be stupid.

It’s worth noting that no matter how complex the history or pattern based AIs get, they all default to the ‘Doug’ algorithm for the first round. This was necessary in order to stick to the non-random ideal of the AI creation. It also reflects my go-to opening move, which means I tend to lose most opening rounds against opponents I’ve played before. This is a potentially common irrational opening move.

**Level Two: ‘Katterina’ aka ‘Copy Kat’**

Katterina copies the moves of the player exactly. Technically she is as organic as the player, since she plays the exact same sequence. However, because a ‘natural’ player reacts to the opponent in strategic ways, it fails to capture the essence of a human player. Again, despite being a simple pattern (something summarised in a single phrase can hardly be considered a complex algorithm) players found it difficult to catch on. In part, this may be because of the necessary one-move delay. In RPS, the focus is very much on the “now”, since a human player can recall a general feel for the past but memorising exact sequences, even their own, and even only one move back, is much more difficult than for an AI. An alternate possibility is that it’s just too bad, too obviously flawed, that regular strategic models formed through RPS experience simply don’t apply. That is, copying your moves exactly is a bad enough model that it appears erratic.

Katterina can be defeated with ‘positive cycling’. That is, the pattern rock, paper, scissors, rock, etc.

**Level Three: ‘Betterina’ (the elder sister of Katterina by three minutes)**

Betterina plays whatever beats the player’s last move. This strategy is no more complex than Katterina’s but makes much more sense to players. It feels more organic, and is easier to beat, like a poor human player rather than an alien way of thinking.

Betterina can be defeated with ‘negative cycling’ (playing scissors, rock, paper, etc.) She can also be defeated by alternating throws (with every second round being a draw). In practice, this is what occurred, with test players almost invariably switching between paper and scissors each round. With the placement of the continue button, this felt more rhythmic than cycling through all three.

**Level Four: ‘Johno Smitho’**

Just your average player, as determined the article in Scientific Reports. After losing or drawing, John switches what would have beaten his opponent last turn. After winning, he plays the same play again.

John is modelled on averages, and biases, and so is much more predictable and less adaptive than most human players. However, because he exaggerates human movements, he feels somewhat natural to play against. Players found John easier to play against because he resembled a simple human player, rather than a simple AI player. Players found him less frustrating, less erratic, and more enjoyable to play against than the previous opponents.

**Level Five: ‘Patty’**

Patty is a pattern matching AI. Unlike the previous AIs, Patty does not attempt to replicate human strategy in any way, instead appealing to her computer-specific talents (namely, superior memory) to analyse the player’s previous moves and predict what they will play next.

Patty looks at the previous move, and checks weather the player has made the same move before. If so, she notes what move was played next. If that worked for the player last time, she assumes they will repeat the move. If not, she assumes they remember what she played last time and will play to beat that.

Then, Patty looks at the previous two moves and see if the player has played that combination before. If so, she updates her guess, and increases the size again. She continues in this manner until she cannot find a match or has found a match of length 6 (with the assumption that 6 will suffice). She plays her latest estimate.

Even though Patty approaches the game from a completely different perspective than any human player (with their inferior, human memories) the same strategy that works against Patty (“be unpredictable and unpatterned” is a reasonable strategy for playing against a human player). Thus, she feels somewhat like a (good) human player, even if she doesn’t think much like one. She tended to win around twice as often as the player, and took some time to defeat.

Patty takes only the most recent repetitions into account, and so is susceptible to alternating strategies.

**Level Six: ‘Squint’**

Much like Patty, Squint analyses recent strings of repetition. However, instead of looking at the pattern of plays, Squint considers the pattern of win-loss-draw. He follows the same method of starting with small strings and increasing the side. When he finds the most recent repeat, he checks whether the player repeated the last move, ‘cycled up’ (e.g. switched from paper to rock), or ‘cycled down’ (rock to paper) and assumes they will do the same again, whether or not it was successful.

Because the winner of the match is calculated for you and the outcome is prominently displayed, the outcome becomes a focus point more than Squint’s actual plays. Squint attempts to take advantage of this by tracking the player’s response to these outcomes. Squint assumes that a pattern of wins and losses will create an emotional state, and hence produce the same next move.

Despite being more sophisticated, Squint tended to be less difficult to beat than Patty. This suggests that the emotional state hypothesis is flawed, overpowered by other factors, or is a contributing but not decisive factor.

**Level Seven: ‘The Oracle’**

The Oracle looks both at the pattern of plays (like Patty) and the pattern of wins and losses (like Squint). Unlike its predecessors, however, it looks further than the most recent move. It goes through the entire history for instances matching the previous play/win combination, recording the “next move” after each. If 90% of these are the same move, it assumes that the player will continue accordingly. If not, however, The Oracle analyses the resultant pattern using the same method (that is, a recursive algorithm), generating an ever deeper meta-analysis of the player’s patterns, until the %90 prediction threshold is reached. With this method, the Oracle is able to recognise long patterns that occur within the player/AI dynamic.

The Oracle, with its time-consuming layers of analysis, is in an entirely different category to the others so far in terms of timing. There are four categories.

1. Fast with low plateau. This algorithm is fast, but ultimately loses if they player has enough time to think about it. An example of this might be a pseudo-random string of throws, or a pattern that takes a human some thinking time to figure out. This is Doug.
2. Fast with high plateau: Skynet. No point worrying about this one, we can’t win.
3. Slow with low plateau: failed Skynet. This is the type of algorithm that spends three hours deciding whether to hit its screen with a hammer or unplug itself. We won’t talk about this one either.
4. Slow algorithm, high plateau. This is the one that most closely resembles human to human play. This is an algorithm that analyses its opposition very well, but takes time to do it. This is the Oracle.

As illustrated below, this gives rise to a new strategy: play faster.

In classic rock-paper-scissors, players count together to time the throws. In this way, effective simultaneity is reached. They both have control over the timing, but it feels like no control, because of the minimal communication. Experienced rock-paper-scissors players may influence the opposition to a speed that benefits them, such as speeding up to give their opponent less time to react. Again, this is reminiscent of fighting games.

In my version of the game, timing is entirely player decided. Against the Oracle, an inefficient but complex decision-making algorithm, a quick reaction gives the best possible player-advantage. This effect has been observed in human/computer games of chess, since chess has such a wide outcome space that computers become significantly disadvantaged against a speedy opponent. The effect is less pronounced against the Oracle, since although inefficient, the algorithm typically has only a short history to process. However, by handicapping the computer to only perform a certain number of calculations per second, we bring back the urgency and excitement of thinking quickly to outsmart your opponent. The extent if handicapping necessary for optimum fun varies from player to player and requires further investigation.

**Level Eight: “Beep Boop”**

Beep Boop steps out of the game’s magic circle and plays a magnet. This interferes with the electronic interface, destroying the game. Both players lose, and the game ends.

Janken, the Japanese RPS robot, also steps outside the magic circle. Playing normally, it would be considered cheating to see what your opponent is playing and quickly change your own play. Janken’s speed accuracy makes a new game out of trying to beat him, where the sense of wonder is more the appeal than actually winning. Hence, we are not discouraged by losses, as the technology defeating our best efforts only increases the sense of wonder and magic. It’s not only the robot world where changes to the rules occur, however.

Players familiar with the game and each other often collaborate on creative variations to the game-play. There are many early recorded variants centred on nature/zen ideologies that are poignantly supplemented by the mechanics, such as “slug-frog-snake.” There are also novelty variations such as “nuclear bomb, cockroach, foot.” In the Philippines, the hand shapes are the same, but each shape is named after the associated martial arts movement: hammer-fist, open hand, and the two-fingered jab. As in the regular rules, an open hand is most effective against hammer but less likely defence against the quick, stiff-fingered jab, and the jab doesn’t stand up against the hammer.

Being a computer-based variation of RPS, it makes sense to reskin the game with a computery theme. Maybe:

* “PC-Mac-Tablet.” Purely opinion/snobbery based: Tablet beats Mac, Mac beats PC, PC beats Tablet. Pros: Pushes an agenda, requires the player to accept the designer’s opinion to play. Cons: unintuitive, requires explanation and it’s easy to forget what is meant to beat what. Or,
* “Cat-Mouse-Keyboard.” Cat beats keyboard by falling asleep on it; mouse beats cat by being inedible; keyboard beats mouse by having more techie-cred. Pros: kitty! This version is based on widely shared views and is easier to learn, but still: Cons: involves a learning curve. Lacks the instant playability of the standard version.

Although the thematic variations add surface level appeal, any creative variations detract from the simplicity of RPS. Creating and playing with those variations are part of a different game than the one my AIs are attempting to capture. This is supported by the fact that the current version, rock-paper-scissors, is far less thematically sound than the philosophical observations on the cyclicity of nature. Why should paper beat rock? And why is stationary teaming up against the landscape? If it was scissors-paper-paperweight, perhaps, it would be a lesson in desk organisation, but even this is a stretch. The fact that this is the most dominant form of the game today suggests that, while the themed versions can be fun for a short time, theme is not the ultimate appeal of the game.

Other variations go beyond simply changing the name and hand gestures by adding throws. An example of this is “rock-paper-scissors-lizard-spock.” Five moves, of course is not the limit, as demonstrated by David C. Lovelace’s RPS-25, which extends the game to include 25 unique hand gestures which each win and lose to half each of the others. Theoretically game can be extended indefinitely, limited only by the players’ imaginations, dexterity, and memory. It can even be extended to have an even number moves by ensuring each move draws against one other. This fact makes repurposing a four-suit deck of playing cards into a zero-sum game with a chance element easier, although initial experimentation has proved less than entertaining.

Beyond this, some variations do not preserve the zero-sum mechanic. Once common variation is the inclusion of “dynamite”, which beats everything. “Magnet” is a tech-themed equivalent.

**Conclusion:**

From Doug to Beep Boop, a wide variety of strategies have been explored. Many of them showcase elements of human play. Of all the (rule abiding) AIs, Patty is the most difficult to defeat, and poses significant challenge. The extent to which each AI succeeds at entertaining the player is left for others to determine.